the assumption that a constant power is being exerted during the stated period capable of developing, as at present, the stupendous energy of 240 millions of foot-pounds in a single minute, for each square foot of the surface of a sphere whose diameter exceeds 850,000 miles. This inconceivable amount of work cannot be performed with a less expenditure than the motive energy developed by the fall of a mass equal to the mass contained in the sun, the weight of which is nearly a thousand times greater than the weight of all the planets of the system. Obviously a *continuous* development of such an amount of energy is physically impossible, since there is a *limit* to the distance through which the weight can fall. Now the foregoing demonstration enables us to determine the said limit, with sufficient exactness to prove that although the efficiency of the great motor, during the past, may be measured by hundreds of millions of years, its future efficiency will be of comparatively brief duration.

Statements relating to the permanency of solar heat, based on the assumption that no diminution has been observed during historic times, have no weight in view of our demonstration showing that a shrinking of $\frac{1}{10}$ of the sun's diameter can only reduce the intensity from 81° to 67°·2, difference = 13°·8, in the course of two millions of years. This period being 500 times longer than "historic times" say 4,000 years, it will be seen that the diminution of the temperature produced by solar radiation, has not exceeded $\frac{13·8}{500} = 0·027$, or $\frac{1}{37}$ deg. Fah. since the erection of the Pyramids.

It will be proper to observe, before concluding our brief investigation of the source of solar energy, that, the development of heat by the shrinking of the sun, however fully demonstrated, leaves the important question unanswered: how is the heat generated by gravitation within the mass transmitted to the surface? If the matter within the sun is a perfect conductor of heat—a very improbable supposition—that fact alone furnishes a satisfactory answer. Imperfect conductivity, on the other hand, calls for other means of transmitting the energy from within, to make good the enormous loss caused by the external radiation. Besides, the falling of the crust at the rate of ten feet per month, attended by increase of internal pressure, and probably ejection of gaseous matter, together with the disturbance occasioned by contraction at the surface, disclose a mechanism of startling perplexity. But the parting with 312,000 thermal units for each square foot of the solar surface, involving an expenditure of kinetic energy fully 240,000,000 foot-pounds per minute, cannot be made good in that brief space of time, unless the sun shrinks at the rate ascertained by our calculations.

The development of solar energy in accordance with the combustion hypothesis (lately resuscitated by M. E. Vicaire) merits no consideration, while careful investigation has proved the meteoric hypothesis to be untenable. It must be admitted, however, that the mechanical difficulties alluded to, especially those relating to the means of transmitting the heat to the surface of the sun, any temporary local derangement of which must be productive of dark spots for a time, are of such a nature that the absolute certainty of solar radiation may be questioned; nor is evidence wanting to show that the solar mechanism is liable to derangement. History informs us that the great luminary has, during several seasons, partially failed to perform its functions. Herschel states, in his "Outlines of Astronomy," that "in the annals of the year A.D. 536 the sun is said to have suffered a great diminution of light, which continued fourteen months. From October A.D. 626 to the following June a defalcation of light to the extent of one-half is recorded; and in A.D. 1547, during three days, the sun is said to have been so darkened that stars were seen in the day-time." Again, the glacial periods, the ascertained abrupt termination and recurrence of which puzzles the geologist, point to periodical derangement of the solar mechanism in past ages.

J. ERICSSON

EXTRAORDINARY WHIRLWIND IN IRELAND

IN a letter to the *Belfast News-Letter*, Mr. C. J. Webb describes an extraordinary whirlwind which occurred in the district around Randalstown, about six miles N.W. of Antrim, near the shores of Lough Neagh, on the 25th of August last. The same phenomenon was witnessed about an hour and a half earlier the same evening at Banbridge, about seven miles S.W. of Dromore. It was first seen near Randalstown about 5 P.M., between that place and Toome, moving rapidly up Lough Neagh from the south, and presenting the appearance of a defined column of spray and clouds, whirling round and round, and not many yards in breadth, while at its base the water was lashed into a circle of white foam. It was next heard of in the neighbourhood of Staffordstown, about a mile from the lake, where it partially unroofed two houses, and damaged any trees or crops which happened to be in its course. From this point it travelled in a straight line for Randalstown, about three miles distant. It passed across a field close to Mr. Webb's house, levelling eight haystacks, and carried a considerable part of the hay up into the air out of sight. The breadth of the storm could be accurately ascertained at this point, and must have extended about thirty yards, as stacks remained unruffled at either side, while those between were thrown down and carried away or scattered about. Everything it lapped up was whirled round and round, and carried upwards in the centre, while dense clouds seemed to be sucked down on the outside, and came close to the earth. Both before and after there was lightning and incessant peals of thunder; but there was no rain till some time afterwards. Mr. Webb next observed its track in a hollow, some three hundred yards further on, where it knocked down a haystack, and then plunged into a wood of fine old Irish oaks. Here it tore numerous branches and limbs from the trees, carrying some along with it, and throwing others to the ground. One noble tree in the centre of the wood seems to have been a peculiar mark for its vengeance, although it would have been completely protected from any ordinary storm, owing to its position. It next passed across a corner of Shane's Castle demesne. Some who were at a short distance from this point describe its approach as causing considerable alarm. It was accompanied by a wild rushing noise, and the crashing of the trees and branches could be heard becoming louder and louder as it advanced. It crossed the valley over the railway viaduct, close to Randalstown, fortunately avoiding the village. It here presented the appearance of a vast whirling column of leaves and branches, mingled with clouds which looked like smoke.

The railway station next suffered, innumerable slates and two and a half cwt. of lead being torn from the roof in an instant. A great part of the railings surrounding the gardens was torn up, and an iron bar one inch thick, belonging to the gate, was bent to an angle of sixty degrees. A small shed at the rear of the station was unroofed, rafters and slates being hurled to the ground. What will give some idea of the excessive pressure of the wind, is the fact that three boards of the flooring of the waiting-room were forced up, owing to the wind finding an entrance to a cellar underneath, though the only aperture was a round hole about one foot in diameter. All this was the work of a few moments. The storm then passed away, leaving comparative calm behind. It next crossed an adjacent bog, scattering the turf in all directions. The last place Mr. Webb heard of its having visited was a farm house about three miles from Randalstown, between Antrim and Ballymena. It would be interesting to ascertain whether it travelled across to the sea-coast.

NOTES

THE British Association Committee on Mathematical Tables, of which Prof. Cayley is the chairman, has determined to tabulate the Elliptic Functions, or more accurately, the Jacobian Theta Functions, which are the numerators and denominators of the former, and their logarithms. The tables, which are of double entry, will therefore give eight tabular results for each

8,100 arguments; besides certain other quantities, depending only on the modulus, that will be added. Forms have been printed, and the calculation has already been commenced. The Elliptic Integrals (the inverse forms to the Functions) were, as is well known, calculated by Legendre, and published in his "Traité des Fonctions Elliptiques, 1826." It is unquestionable that the Elliptic Functions are the most widely used transcendents in analysis that have not yet been tabulated, and it is believed that the tables will be found very generally useful in all the mathematical sciences. The great labour has no doubt alone prevented any previous attempt. The work proposed by the committee will, when completed, be most likely the largest piece of numerical computation, with general application throughout the whole of mathematics, that has been undertaken since the original calculation of the logarithms of numbers and trigonometrical functions of Briggs and Vlacq, 1620–1633.

DR. FREDERICK WELWITSCH, the well-known African explorer and botanist, died at his residence in London on Sunday, the 20th inst., in the 66th year of his age. A native of Carinthia, Dr. Welwitsch studied medicine at Vienna, and early devoted himself to botanical pursuits. When on a visit to Portugal, he was induced to take up his residence at Lisbon as Director of the Botanical Gardens there, and in 1853 was despatched by the Portuguese Government to Angola to investigate the natural history of that region, where he remained from 1853 to 1861. His collections of the vegetable productions of that country are unrivalled in extent and completeness, have established a new region in geographical botany, and have been copiously used in the compilation of the two volumes already published under the auspices of the authorities at Kew of the "Flora of Tropical Africa." Dr. Welwitsch was not himself an extensive writer, but the number of species new to science discovered by him and described by others is very large, among the most remarkable of which is one of the most extraordinary vegetable productions known, dedicated to him by Dr. Hooker, the *Welwitschia mirabilis*. He was also an accomplished zoologist, and his entomological collections are of great extent and value. It is understood that the British Museum will have the first option in the purchase of the most valuable part of his collections.

THE death on Monday, 21st inst., is announced of the physicist, M. Jacques Babinet, the academician, at the age of 78 years. He was elected to the Academy in 1840. Another member of the Academy, M. Puiseux, has also just died.

SIR JOHN LUBBOCK and Mr. Grant Duff are now travelling in Asia Minor; and it is expected they will bring home some very important and interesting information on the pre-historic remains of that region, an almost untried hunting-ground.

THE *Gardener's Chronicle* states that it is proposed that the sum of 48,000*l.* shall be included by the French Government in the Budget of 1873 for the commencement of the entire rebuilding of the museums and conservatories of the *Jardin des Plantes*, a move which has been long in contemplation. In addition, the vote for civil buildings for 1873 includes a sum of 8,000*l.* for the construction of laboratories of chemistry and zoology in the Museum for the *Ecole des Hautes Etudes*, and for the completion of the reptile house.

THE Board of Trinity College, Dublin, has elected Dr. Benjamin M'Dowell to the Professorship of Anatomy and Surgery, and has resolved to found a new Professorship of Comparative Anatomy, endowed with 100*l.* a year and a portion of the fees for dissections. The professor will have to deliver eighteen lectures each year.

THE Swiney Lectureship, which has just been vacated by Dr. Cobbold, will be filled up in February. It is a travelling Lectureship, open to Doctors of Medicine of Edinburgh University, and is tenable for five years.

THE statue to the memory of Sir Humphrey Davy has just been erected at Penzance, his native place. The statue, which cost 600*l.*, is a colossal one, and stands on a massive granite pedestal in front of the Post Office, and a few yards from the house in which the great chemist, philosopher, and inventor was born.

WE learn from the *Mechanics' Magazine* that a committee of the Derby and Chesterfield Institute of Engineers has been appointed to consider the possibility of erecting a memorial hall, to cost 20,000*l.* to 30,000*l.*, in memory of George Stephenson.

IN reference to Mr. J. R. Hind's letter to the *Times*, printed in its issue of Oct. 19th, on the subject of the probable existence of a planet revolving round the sun within the orbit of Mercury, we propose to revert to the subject as soon as Mr. Hind has further discussed the subject; as we learn that in consequence of errors in some of the calculations made by some who have previously inquired into the subject, a revision of some of the results announced in the letter in question is necessary.

AN admirable article has appeared in *Engineering*, under the heading, "Great Britain in Formâ Pauperis." The burden of the writer is the parsimonious, nay, even ungratefully insolent manner, in which the neighbourly request of Austria for a reciprocity of assistance (such as she and other nations afforded to England in 1851 and 1862) in the forthcoming Universal Exhibition at Vienna has been met by the Government and the Treasury. It appears, that whereas France, torn and bleeding at every pore, votes 60,000*l.*, her conqueror, Prussia, an equal sum, with a supplementary vote, Italy the same sum, Spain 1,200,000 reals, the minor states of Europe in proportion, even little Switzerland voting 16,000*l.*, Great Britain, wealthy and powerful, the ancient friend and ally of Austria, who has contributed to her exhibitions over 100,000*l.*, votes the noble, magnanimous sum of six thousand pounds sterling! We fully sympathise with the indignant comments of our contemporary at the lamentable parsimony for which our Government has made us responsible.

THE *Gardener's Magazine* announces its full adhesion to the views enunciated in our article on the potato disease, that it is in its origin cosmical, and probably connected with the great cycle indicated by the recurrence of sun-spots.

THE total number of entries at the various medical schools of London for the session just commenced is 1496, of which 476 are of new students, the former number being 21, and the latter 8 in excess of those last year. Guy's and University College Hospitals occupy the first place, each with 83 fresh entries. Westminster brings up the rear with 4.

THE prizes of the Charles Science and Art School, Plymouth, were distributed on Friday, Oct. 21, by Sir Massey Lopes, Bart. M.P., who spoke very encouragingly of the success of the schools.

MR. THOMAS WEBSTER, Q.C., F.R.S., will read a paper before the members and friends of the London Association of Foremen Engineers and Draughtsmen "On the Promotion of Practical Science and Technical Education by Museums of Inventions established and maintained by the Surplus of the Inventors' Fee Fund," at the meeting to be held on Saturday, the 2nd of November, at the City Terminus Hotel, Cannon Street, at 8.30 P.M.

THE Council of the Institution of Civil Engineers invite communications dealing in a complete and comprehensive manner with such subjects as (*a*) Account of the Progress of any Work in Civil Engineering, as far as absolutely executed —Smeaton's Narrative of the Building of the Eddystone Lighthouse may be taken as an example; (*b*) Descriptions of distinct classes of Engines and Machines of various kinds; (*c*) Practical Essays on Subjects allied to Engineering, as for instance, Metallurgy; and (*d*) Particulars of Experiments and Observations connected with Engineering Science and Practice. A list of thirty seven special subjects recommended for competition is appended. For approved original communications, the Council will be prepared to award the premiums arising out of special funds devoted for the purpose.

THE Crystal Palace Company's school of Art, Science, and Literature, has issued its prospectus for the thirteenth session, 1872-73, of classes for gentlemen, conducted by eminent professors and teachers.

THE following are the Science Lectures for the People to be given this winter at Manchester:—The first on Tuesday, Oct. 29, by Prof. Roscoe, F.R.S., On the Rainbow; and these other lectures will follow:—Prof. Geikie, F.R.S., On the Ice Age in Britain; Prof. Balfour Stewart, F.R.S., The Sun and the Earth; Prof. Clifford, On Atoms; Prof. Barrett, On Faraday's Electrical Discoveries; Dr. J. H. Gladstone, F.R.S., The Life of Faraday; Mr. William Pengelly, F.R.S., Prehistoric Man. The fee for each of these lectures, as before, is one penny! Many people will wish they lived in Manchester.

THE following lectures will be delivered in Gresham College, Basinghall Street, E.C., by E. Symes Thompson, M.D.; On Draughts, Friday, Nov. 8; On Mineral and Vegetable Tonics, Monday, Nov. 11; On Prescriptions, Tuesday, Nov. 12. The lectures are illustrated by diagrams and experiments, are free to the public, and commence each evening at seven o'clock.

THE following lectures are announced to be delivered in connection with the Torquay Natural History Society:—Introductory Address, by Dr. Wilks (President), Nov. 4. The Fertilisation of Flowers, by Dr. Wilks, Nov. 25. "Natural Selection," by Dr. Wilks, Dec. 2. Museums and Our Museum, by the Rev. T. R. R. Stebbing, M.A., Dec. 9. Fossils as characteristic of Strata, by J. E. Lee, F.G.S., F.S.A., Dec. 16. The Share of the Italians in the Progress of the Natural Sciences, by Signor Olivieri, Lit. and Phil. Doctor, Jan. 27, 1873. The Unity and Progress of Man, by J. B. Paige Browne, March 3. Monte Rosa—its Peaks, Valleys, and Glaciers, by Dr. Wilks, March 17. Teleology, by Rev. T. R. R. Stebbings, M.A., March 24. Curiosities of Natural History, by Dr. C. Paget Blake, April 7. Aërostation, by W. Froude, F.R.S., April 21.

IN addition to our announcements of last week, Mr. Van Voorst announces as follows:—Mr. W. Saville Kent, of the British Museum, is engaged upon a new "Manual of the Infusoria:" the treatise will be devoted entirely to the Ciliate, Flagellate, and Suctorial Protozoa, to the exclusion of the Desmids, Diatoms, Rotifers, and other foreign organisms comprised under the above title by Ehrenberg, Pritchard, and other writers; the Rev. Thomas Hincks is preparing for publication "A History of British Polyzoa" with figures of all the species, uniform with his "Hydroid Zoophytes;" "The Birds of the Humber district," by John Cordeaux of Great Cotes, Ulceby, is in the press; a second edition, with new plates and additions, of "Falconry in the British Isles," by Capt. Salvin and Wm. Brodrick, is in preparation.

THE Zoological Society has just issued a revised list of the valuable animals now or lately living in the Society's Gardens. It contains a list of nearly 500 Mammalia, upwards of 1,000 Aves, and nearly 300 Reptilia, Batrachia, and Pisces, with their habitats and dates of acquisition, and is illustrated by 30 very well-executed woodcuts. As the list is published at the very low price of 2*s.*, it ought to be in the hands of every one who is in the habit of using the Gardens.

PROF. MIGUEL COLMEIRO, director of the Botanic Garden at Madrid, announces the publication of the second edition of a "Treatise on the Elements of Botany, organographic, physiological, systematic, and geographical," in two vols., with numerous illustrations. Prof. Colmeiro is the author of thirty separate papers on botanical subjects.

A SECOND edition is announced as in the press of Gardiner's "Flora of Forfarshire," edited by Mr. John Sadler, author of the "Flora of Edinburgh." Many important additions will be made to the original work, in which the editor will be assisted by resident botanists, and the author's valuable notes on the different species, and on various localities of special interest, will be retained.

JOHN HEYWOOD'S recently-published School Atlas is a marvel of cheapness. It contains twelve coloured maps about 10 in. by 8 in., of Europe, the two hemispheres, England and Wales, the British Isles (physical), Scotland, Ireland, Asia, Africa, North and South America, and Australia; and the price is Sixpence!

THE following we take from the *School Board Chronicle*:—"Some curious statistics have been published, establishing a suggestive comparison between the expenses of education and police supervision in the cities of St. Petersburg, Berlin, and Vienna. With regard to education, the expenses of the Russian capital are estimated at one per cent. of the total budget; Vienna stands as high as nine per cent.; and Berlin reaches thirty-one. Costs of philanthropic institutions are represented by the proportions of Berlin, twenty-two; Vienna, fifteen; and St. Petersburg, nine per cent. Of course, the ratio becomes inverted when we turn to the expenses of the police force. Here we find Prussia down for seventeen, Austria for twenty-one, and Russia for fifty-one (figures of comparison). Berlin employs one policeman for every 495 of its inhabitants, Vienna one for every 416, and St. Petersburg one for every 210. The practical teaching of these statistics is, that while Berlin pays twice as much for schools as for prisons and police, Vienna pays two and one-third times less, and St. Petersburg fifty times less."

THE same journal prints the following item of information:—"Reports concerning the four Prussian academies for the scientific pursuit of agricultural knowledge inform us that these institutions have been frequented during the past summer term by 173 students. Of these 65 were newly matriculated, and 10 unmatriculated. Classified according to their nationality there were 117 from Prussia, 13 from other German States, and 43 foreigners. In order of academic population Proskau stands first with 63 students; then comes Poppelsdorf, near Bonn, with 43; after that the institution at Berlin with 37; and last of all the Academy at Eldena with 30 students.

THE following, in reference to education in Greece, is again from the same journal:—"From 1835 to 1869, the number of students at the University of Athens had increased from 35 to 1,205; the number of gymnasia in Greece, which was 3 in 1835, had risen to 16 by the year 1866. During the same period of time the number of secondary schools had increased from 21 to 189, and that of the pupils frequenting them from 2,500 to 7,300; within 33 years, also (1833-66), the national elementary schools had increased from 17 to 1,070, and the scholars from 8,000 to 65,000. Among the secondary schools there were, in 1869, 6 institutions for girls, numbering 680 pupils. As a sorrowful set-off to such cheering news, it must be mentioned that there are still in Greece 240,000 children and youths who receive no education whatever; that is to say, more than three times the number of those who frequent the schools.